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Original Research Article

Predictors of Surgical Site Infection: A Retrospective Study from A Tertiary Care Hospital of Coastal Odisha

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Abstract:

Background: Surgical site infections (SSIs) are infections that occur within 30 days of surgery (or up to one year if implants are involved). These infections are a major concern, especially for complex surgeries, and are the third most common hospital-acquired infection. This study retrospectively examines factors that predict SSIs in patients who underwent surgery at a tertiary care hospital.

Materials and Methods: This hospital based retrospective study was undertaken to examined the predictive risk factors for SSIs among patients admitted to the Department of General Surgery at Shri Jagannath Medical College and Hospital, Puri, Odisha, India, over a one-year period. Existing medical records of patients was reviewed to collect data on SSIs.

Results: Maximum numbers of SSI cases were observed the age >60 years (55%).The duration of surgery (>2hrs) was associated with high number of SSI cases. Exploratory laparotomy (31%) was the procedure most commonly associated with SSI followed by appendectomy (27%).

Conclusions: Present study found that, increasing age of the patient, contaminated wound, prolonged duration of surgery, absence of prophylactic antibiotics, use of drains and prolonged hospital stay are associated with increased incidence of SSI.

Keywords: General surgery, Nosocomial infection, SSI, Surgical site infection, Surgery.

Introduction

Surgical site infections (SSIs) are a major concern after surgery, second only to urinary tract infections as the most common hospital-acquired infection [1]. These infections can vary in presentation. The Centers for Disease Control and Prevention (CDC) classifies SSIs into three main types based on the depth of tissue involved [2-4]. Superficial incisional SSIs (SSSIs) affect only the skin and fatty tissue around the incision. Deep incisional SSIs (DSSIs) involve deeper soft tissues like muscles and fascia. Finally, organ space infections (OSIs) occur in any part of the body that was cut into or manipulated during surgery, excluding the incision itself.

Modern infection control practices, like better ventilation in operating rooms, advanced sterilization methods, protective barriers, improved surgical techniques, and wider use of antibiotics before surgery, have significantly reduced infections. However, SSIs can significantly extend a patient's hospital stay and drive up costs due to increased use of antibiotics and lab tests. These infections also raise the likelihood of needing ICU care (by 60%), hospital readmission (by 5 times), and even death (twice the rate of non-infected patients). This could be due to the rise of antibiotic-resistant bacteria and the growing number of surgical patients who are older, have chronic health conditions, or compromised immune systems. Additionally, the increase in surgeries involving prosthetic implants and organ transplants creates new challenges for infection control [4].

Importantly, an estimated 40-60% of SSIs are preventable. To assess how prevalent SSIs are, this study investigated patients in the Department of Surgery. The aim of the study is to retrospectively evaluate the predictors of surgical site infection patient underwent surgery in a tertiary care hospital.

Materials and Methods

This hospital based retrospective study was undertaken to examined the predictive risk factors for SSIs among patients admitted to the Department of General Surgery at Shri Jagannath Medical College and Hospital, Puri, Odisha, India, over a one-year

period. Existing medical records of patients was reviewed to collect data on SSIs.The data such as type of surgery performed (categorized by wound class), surgery type and duration, use of preventative antibiotics (antimicrobial prophylaxis), drains used, length of stay before surgery (preoperative stay), and total hospital stay. Each patient's information was tracked from admission to discharge and 30 days post operative outcome data was also collected.

Inclusion Criteria: All patients who undergone surgeries.

Exclusion Criteria: Patients who are not undergone surgeries

Patients who undergone surgery with previous infection

Small infections around stitches (stitch abscesses) were excluded

A wound infection (surgical site infection or SSI), was diagnosed if it showed any of these signs:

- Drainage of clear fluid (serous) or non-pus discharge along with redness, swelling, warmth, increased local temperature, fever above 38°C, tenderness, and hardening of the wound area.
- Deliberate reopening of the wound by the surgeon due to a localized fluid collection (either clear fluid or pus).

Small infections around stitches (stitch abscesses) were excluded. Identified SSIs were then categorized into three types:

1. Superficial incisional SSI: Infection occurring within 30 days of surgery.
2. Deep incisional SSI: Infection occurring within 30 days of surgery if no implant was used or within one year if an implant was left in place.
3. Organ/space SSI: Deep infection involving organs or body spaces near the surgical site.

The infection involved only skin and subcutaneous tissue in superficial incision SSI, deep soft tissue (e.g. fascia, muscle) of the incision in deep incision SSI and any part of the anatomy (e.g., organs and spaces) other than the incision which was opened or manipulated during an operation in organ/space SSI and at least one of the following:

- Purulent drainage from the superficial/deep incision (in superficial/deep incision SSI) and from a drain (inorgan/space SSI)
- Organisms isolated from an aseptically obtained culture of fluid or tissue from the incision (in superficial SSI and organ/space SSI)
- At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat and superficial incision is deliberately opened by surgeon, unless incision isculture-negative (in superficial/deep incision SSI)
- An abscess or other evidence of infection is found on direct examination, during reoperation, or by histopathologic or radiologic examination (in deep incision SSI and organ/space SSI).

To minimize surgical site infections (SSIs) for all elective surgeries, our institution follows a strict protocol. Before surgery, patients undergo hair removal near the incision site if necessary, and diabetic patients receive measures to control blood sugar levels. Additionally, patients take an antiseptic bath and have their skin prepped with an antiseptic agent. The surgical team strictly adheres to universal precautions. All patients receive preventive antibiotics, typically administered intravenously. During surgery, standard sterilization and disinfection procedures are followed. Finally, we promote early discharge whenever possible to further reduce the risk of SSIs.

Results

During the study period, Medical record of 248 patients who underwent various surgical procedures from the hospital was collected based on the selection criteria out of which 146 (%) patients were male and 102 (%) were female patients. Majority of the patients who underwent surgery belongs to the age group of 31 to 40 years (19.7%) [Table 1].

Table 1. Age and sex wise distribution of study population.

Age Group	Total (N=248)		Male (N=154)		Female(N=94)	
	n	%	n	%	n	%
<10	3	1.2	3	1.9	0	0
20-2I	18	7.3	9	5.8	9	9.6
21-30	43	17.3	21	13.6	22	23.4
31-40	66	26.6	38	24.7	28	29.8
41-50	46	18.5	39	25.3	7	7.4
51-60	31	12.5	21	13.6	10	10.6
61-70	20	8.1	11	7.1	9	9.6
71-80	16	6.5	9	5.8	7	7.4
>81	5	2.0	3	1.9	2	2.1

This study examined surgical site infections (SSIs) at the Department of General Surgery from January to December 2022. It included 239 elective and 9 emergency surgeries. The overall SSI rate was 15% (35 cases) for elective surgeries and 22% (2 cases) for emergency surgeries. Patients over 60 years old had the highest number of SSIs (55%). Longer surgeries (over 2 hours) were also linked to a higher risk of SSI. Exploratory laparotomy (31%) was the most common procedure associated with SSI, followed by appendectomy (27%).

The severity of the SSI impacted hospital stay. Patients with deep incisional or organ/space SSIs spent an average of 2 days in the ICU (range: 0-12 days). These patients also had a longer average hospital stay compared to those with superficial SSIs (7 days vs. 2 days). Superficial SSI patients were typically transferred directly to their ward after recovery, while those with deeper infections required extended stays (superficial: 0-8 days, deep incisional: 2-11 days, organ/space: 4-18 days).

Table 2: Rate of SSI in clinicopathological variables

Variables		Total No (N=248)		Rate of SSI (N=37)	
		n	%	n	%
Sex	Male	154	62.1	24	15.6
	Female	94	37.9	13	13.8
Age	<30	64	25.8	9	14
	31-60	143	57.7	17	12
	>60	20	8.1	11	55
Timing of surgery	Elective	239	96.4	35	15
	Emergency	9	3.6	2	22
Duration of surgery	0-1 hour	113	45.6	16	14
	1-2 hours	96	38.7	12	13
	>2 hours	39	15.7	9	23
Surgical procedure	Colon	29	11.7	6	20
	Gastric	24	9.7	1	2.7
	Hepato-pancreatico-biliary	31	12.5	4	10.8
	Exploratory laparotomy	22	8.9	7	31
	Appendectomy	58	23.4	10	27.0
	Hernia repair	51	20.6	3	8.1
	Urological	33	13.3	6	16.2
Diabetes	Yes	112	45.2	28	75.7
	No	136	54.8	9	24.3
Wound classifications	Clean	127	51.2	0	0.0
	Clean contaminated	27	10.9	19	51.4
	Contaminated	18	7.3	18	48.6
Drain used	Yes	132	53.2	28	75.7
	No	116	46.8	9	24.3
Antibiotic prophylaxis given	Yes	167	67.3	11	29.7
	No	81	32.7	26	70.3
Total hospital stays	<2 days	107	43.1	10	27.0
	2-5 days	94	37.9	16	43.2
	> 5 days	47	19.0	11	29.7

Discussion

Our study found a higher proportion of males undergoing surgery compared to females. This aligns with a previous study reporting that males more frequently have surgery (51.94%). However, previous study which showed a higher incidence of SSI in females.[1,2]. In this present study such difference was not noted between the two sexes.

Our study found the highest infection rate (55%) in patients aged 60 or older. This aligns with other research reporting a similar trend of higher infection rates at older ages (51-60 years) [1, 2, 5, 6, 7]. The increasing incidence of SSI with age likely correlates with a weakened immune system and a higher prevalence of underlying health conditions (comorbidities) such as diabetes and anemia. Additionally, reduced adherence to post-surgical care instructions in older patients could contribute to this trend.

Surgical site infections (SSIs) are a major concern after surgery, representing the most frequent complication and nearly a quarter of all hospital-acquired infections [5]. This study found a higher SSI rate for emergency surgeries (22%) compared to elective procedures (15%). Exploratory laparotomy was the surgery most associated with SSIs, and the

incision site itself was the most frequent location of infection (8.2%).

Our study found a similar rate of surgical site infections (SSI) in elective surgeries compared to other studies conducted in developing countries (15%) [6]. This rate is higher than those reported in developed nations like the UK (3.1%) and the Netherlands (4.3%) [7, 8]. Within Asia, our results show a higher incidence of SSI than some previous studies [1,5, 9]. However, it's important to note that SSI rates can vary widely, with reports ranging from 20% to a staggering 76.9% [8-12, 15].

Our study found that exploratory laparotomy had the highest infection rate (31%) among surgical procedures. Appendectomy also showed a high rate (16%). These rates are more than double what's reported in European studies and the US National Nosocomial Infections Surveillance (NNIS) system (16-19). This difference might be due to stricter hygiene protocols in developed countries. However, variations in data collection and surveillance methods across regions could also play a role.

Our study found a higher rate of surgical site infections (SSIs) in emergency surgeries (22%) compared to elective procedures (15%). This aligns with previous research suggesting a higher SSI risk in emergencies [13, 20-23]. This could be due to several factors: emergency surgeries often involve contaminated or clean-contaminated wounds, less frequent use of preventive antibiotics, and longer surgery durations compared to elective procedures.

The study found a significantly higher rate of surgical site infections (SSI) in surgeries lasting longer than 2 hours (23%). This increased risk is likely due to several factors. Longer procedures expose the surgical site to air for a more extended period, potentially increasing the chance of contamination. Additionally, prolonged surgery can lead to greater tissue trauma, stress on the body from extended anesthesia, and sometimes even blood loss, all of which can weaken the body's defenses and make it more susceptible to infection.

Our study found that A beta hemolytic streptococci and Staphylococcus aureus (SA) were the most frequent culprits behind surgical site infections (SSIs). Staphylococcus aureus, in particular, has long been recognized as a major global cause of SSI. This prevalence stems from SA's ability to easily colonize human skin and nasal passages. Up to 50% of healthy people carry SA in their noses, and this rate increases in individuals with chronic illnesses like diabetes or kidney disease. Importantly, carriers of SA are two to nine times more likely to develop SSIs compared to non-carriers [24]. Further strengthening this link, studies have shown that in 85% of cases, the strain of SA causing a post-surgical infection is identical to the one found in the patient's nose before surgery [25].

Studies have shown a higher risk of SSI when antibiotic prophylaxis is not administered. Recognizing this, the Centers for Medicare and Medicaid Services (CMS) partnered with the CDC in 2002 to develop the Surgical Infection Prevention Project [26]. This project aimed to establish evidence-based guidelines for appropriate antibiotic use in elective surgeries with a moderate risk of infection (clean-contaminated procedures). Their recommendations focused on three key areas: timing, selection, and duration. Ideally, antibiotics should be given within one hour before the incision begins, with a two-hour window for vancomycin or fluoroquinolones. The specific antibiotic should be chosen based on the planned procedure. Finally, to minimize unnecessary exposure, antibiotics should be stopped within 24 hours of surgery completion (48 hours for heart and chest surgeries). For most clean-contaminated procedures (like those in heart, gut, bones, blood vessels, or women's health), a cephalosporin antibiotic is typically recommended.

Our study found a link between drain placement and a higher rate of surgical site infections (SSIs). Drains are typically used during surgery to prevent collections of pus (abscesses) or blood clots (hematomas). However, they might also introduce bacteria into the wound, potentially causing SSIs. This could happen through contamination along the outside of the drain (external) or through the inside of the drain (luminal), allowing bacteria to travel backwards (retrograde) into the wound.

Closed-suction drains (CSDs) are designed to minimize this risk. Unlike open drains, they create a pressure difference that draws fluids out of the wound and into a sealed container. Research on the impact of routine post-operative CSDs on SSI risk across different surgeries has produced mixed results. While some studies suggest an increased SSI risk with drains, these often involve open drains, not CSDs. Importantly, no studies have shown a decrease in SSIs (including deeper organ/space infections) from drain placement. Additionally, drains can lead to other complications like fistulas (abnormal connections between the intestine and skin), pain, irritation, and the need for more blood transfusions [27].

The cost of care for patients with surgical site infections is nearly threefold higher than that for surgical patients without the infections during the first eight weeks after hospital discharge. These infections reduce patients' quality of life and account for excess hospital days and more in excess costs .Furthermore, patients who develop surgical site infections are five times more likely to be readmitted to the hospital, 60 percent more likely to spend time in the intensive care unit, and twice as likely to die compared with surgical patients without the infections [26].

Limitations of the Study:

The study was limited by its small size and the inclusion of a very small number of cases. Ideally, the study should have included all patients who underwent surgery. Other possible risk factors like hair removal at a surgical site, skin preparation for surgery, blood glucose level, hypothermia during surgery, antiseptics used for patient preparation could no be analyzed in this study. To strengthen the findings, a future study with a larger population across multiple centers would be beneficial.

Conclusion:

Present study found that, increasing age of the patient, contaminated wound, prolonged duration of surgery, absence of prophylactic antibiotics, use of drains and prolonged hospital stay are associated with increased incidence of SSI.

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